MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

ECE1026 ALGORITHMS AND DATA STRUCTURES

(All Sections / Groups)

3 JULY 2023
9:00 A.M – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 8 printed pages including the cover page with 4 questions only.

2. Attempt all FOUR (4) questions. All questions carry equal marks and the distribution of marks is given in the questions.

3. Please print all your answers in the answer booklet provided.

4. State all assumptions clearly.

Question 1

(a) A Finite State Machine (FSA) is shown in Figure Q1(a).

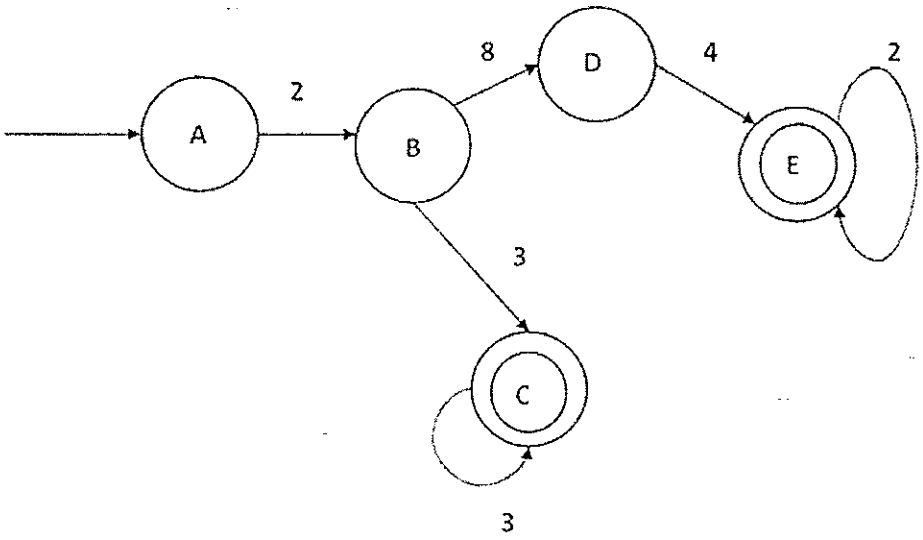

Figure Q1(a)

Based on Figure Q1(a),

(i) Write the Regular Expression (RE) for this FSA.

[6 marks]

(ii) List the set of all states (Q), the set of all input symbols ($\sum$), the initial state (q_0), and the set of final states (F) for this FSA.

[6 marks]

(iii) Write down **TWO (2)** accepted words for this FSA.

[4 marks]

(b) Draw a finite state diagram that will accept the RE = H*D(S | N+).

[4 marks]

Continued...

(c) Given the Turing Machine (TM) in figure Q1(c), write down the content of the tape and the position of the read/write head at the end of the execution when the machine stops. Assume that the read/write head is pointing to the first left of non-blank square (i.e. letter with square T)

[5 marks]

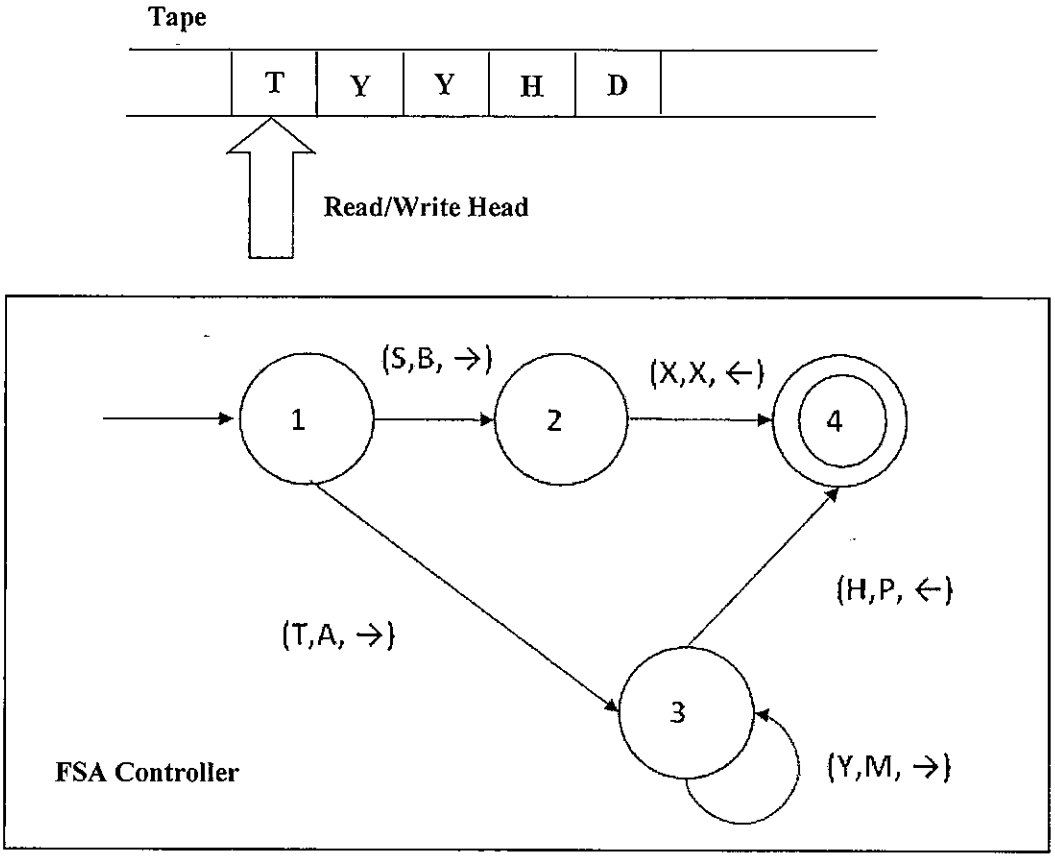

Figure Q1(c)

Continued...

Question 2

(a) Study the following C program in Program Listing Q2(a)

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#define N 10

//Answer for Part(a)(i)

struct Sensor *newSensor(int id, char location[], float humidity {
  //Answer for Part(a)(ii)
};

int main() {

  struct Sensor *head = NULL, *curr = NULL;

  //Answer for Part(a)(iii)

  //Answer for Part(a)(iv)

  return 0;
}
```

Program Listing Q2(a)

Table Q2(a)

Sensor ID	Location	Humidity (%)
3001	Living	49.2
3002	Garage	54.1
3003	Bathroom	65.5
3004	Kitchen	48.4

Table Q2(a) shows the sensor data collected from four types of IoT sensors in a smart home. The columns provide information on the sensor ID, location and humidity.

(i) Define a **linked list node** structure named `Sensor` that contains the sensor ID, location and humidity (see Table Q2(a)).

[3 marks]

(ii) Write the function definition for `newSensor` that will create and initialize a new `Sensor` node.

[4 marks]

(iii) Write C statements to build a linked list to store data in Table Q2(a). Use the `newSensor` function.

[4 marks]

Continued....

(iv) Write C statements to **find** and print the sensor that records the highest humidity, as shown below:

```
The 3004 sensor which is located in Bathroom, has the
highest humidity.
```

[4 marks]

(b) Study the following C program in Figure Q2(b).

```
typedef unsigned int Set;
#define SETSIZE 32

void printSet(Set s)
{
    int j;
    printf("{ ");
    for(j=0; j<SETSIZE; j++)
        if((1<<j)&s) printf("%d ",j);
    printf("}\n");
}
```

Program Listing Q2(b)

Using linear bitmap implementation of sets and 16-bit data byte, write C statements to complete the tasks listed below. A sample output is as shown in Figure Q2(b). (Note: Use Program Listing Q2(b) as your reference)

```
X = { 4 8 17 30 }
Y = { 2 3 8 17 25 }
X intersection Y = { 8 17 }
Update Y = { 2 3 8 11 17 25 }
```

Figure Q2(b)

(i) Declare and initialize set `X` = {4, 8, 17,30}, `Y` = {2, 3, 8, 17, 25} and print them.

[6 marks]

(ii) Find and print the intersection of `X` and `Y`.

[2 marks]

(iii) Insert element 11 into set `Y` and print the updated set `Y`.

[2 marks]

Continued...

Question 3

(a) Consider the recursive formula:

$$J(t) = \begin{cases} 5 & t = 0 \\ t - K(t-1) & t > 0 \end{cases}$$

$$K(t) = \begin{cases} 8 & t = 0 \\ t - J(t-1) & t > 0 \end{cases}$$

(i) Write *two* mutually recursive functions in C programming language based on the formula above. Assume `t` is an integer greater or equal to `1`.

[6 marks]

(ii) Compute the values of `J(t)` and `K(t)` for `t = 3, 4, 5`.

[6 marks]

(b) In your own words, describe backtracking algorithm and its area of application.

[4 marks]

(c) Consider the binary tree in Figure Q3(c). Write down the sequence of the binary nodes visited for each of the following traversal algorithms.

(i) Preorder Traversal
(ii) Postorder Traversal
(iii) Inorder Traversal

[3 + 3 + 3 marks]

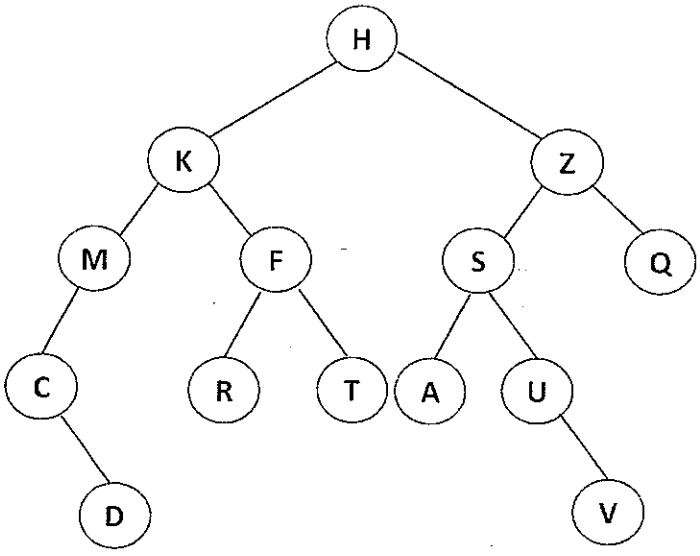

Figure Q3(c)

Continued...

Question 4

(a) Suggest a suitable *search* algorithm for each of the following array. Explain your answer.

$$Data1 = [6666 \quad 0.666 \quad 66.66 \quad 1.666 \quad 1066 \quad 10.66 \quad 6006]$$

$$Data2 = [\text{"}a\text{"} \quad \text{"}black\text{"} \quad \text{"}cat\text{"} \quad \text{"}dropped\text{"} \quad \text{"}eleven\text{"} \quad \text{"}fish\text{"} \quad \text{"}gently\text{"}]$$

[4 marks]

(b) The incomplete C program as shown in Program Listing Q4(b) implements a sequence search on an array of employee records. Study the code snippet carefully and answer the following questions.

```
#include <stdio.h>
#include <string.h>

struct Employee {
   char name[50];
   int age;
   float salary;
};

int SequenceSearch(char *empname, struct Employee data[]);
void DisplayResult(int index, struct Employee data[]);

int main() {
   char search_name[50];
   int index;
   struct Employee list[] = {{"Jon",36, 2650.00},
                             {"Helen",22,2100.50},
                             {"David",29,3900.80},
                             {"Brad",52,4500.70},
                             {"Anna",41,2250.30}};

   printf("Enter the name of employee: ");
   scanf("%s", search_name);

   index = SequenceSearch(search_name, list);
   DisplayResult(index, list);

   return 0;
}

/*Answer for Part(i) - Function definition for SequenceSearch*/

/*Answer for Part(ii) - Function definition for DisplayResult*/
```

Program Listing Q4(b)

Continued ...

(i) Write the function definition for `SequenceSearch` that implements a *sequence search* to search for a name of employee in an array of records. If a match is found, the function returns the index of the matching element, otherwise it returns `-1`.

[5 marks]

(ii) Write the C function `DisplayResult` that prints out the age and the salary of the selected employee. If the index equals -1, display "`Data is not found`" instead.

[4 marks]

(c) Briefly explain the difference between the selection and the insertion sorting algorithms.

[4 marks]

(d) Sort by hand (no coding required) the word "`OUTSTANDING`" in *ascending* order using the following sorting algorithms. Show all steps involved.

(i) Selection sort

[4 marks]

(ii) Insertion sort

[4 marks]

End of Paper